AMENDMENTS TO THE CLAIMS

This listing of claims replaces all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) A method for detecting a patterned object placed adjacent to an interactive display surface, the interactive display surface having a surface origin, and a plurality of surface coordinate locations defined along two orthogonal axes in relation to the surface origin, comprising the steps of:

preparing a stored template for runtime by:

loading a stored template,

computing an intensity sum of the stored template,

iteratively rotating the stored template in predefined increments through a full 360 degree rotation, and

computing moments of pixel intensities of the stored template, itself, from the rotated stored template image by determining a mean and covariance of pixel intensities of the rotated stored template image;

detecting a physical property of the patterned object when the patterned object is placed adjacent to an object side of an interactive display surface;

creating a template of the patterned object at a known orientation, the template comprising a quadrilateral template bounding region having a side aligned with one of the two orthogonal axes; ~~[[and]]~~

creating a set of template data values associated with the quadrilateral template bounding region, each template data value representing a magnitude of the physical property at a different one of a plurality of surface coordinate locations within a bounding area encompassing the patterned object;

~~computing a sum of the set of template data values;~~

acquiring input data values from the interactive display surface, each of the input data values corresponding to a different one of the plurality of surface coordinate locations of the interactive display surface, each input data value representing a magnitude of the physical property detected at a different one of said plurality of surface coordinate locations;

calculating a difference score between the template data values and the input data values

encompassed by the quadrilateral template bounding region; and

when the difference score is within a match threshold, determining that the patterned object is on or adjacent to the interactive display surface.

2. (Previously Presented) The method of Claim 1, further comprising the step of determining

whether an integral sum of the input data values encompassed by the quadrilateral template bounding region is within a first threshold of the sum of the set of template data values, and when so, proceeding with the step of calculating the difference score.

3. (Original) The method of Claim 1, wherein:

(a) the physical property that is detected comprises light intensity;

(b) the template data values comprise pixel values, each pixel value indicating an intensity of light reflected from the patterned object while the patterned object is adjacent to the interactive display surface in a template acquisition mode; and

(c) the input data values comprise pixel values indicating an intensity of light reflected from the patterned object while the patterned object is adjacent to the interactive display surface in a run-time mode.

4. (Original) The method of Claim 2, further comprising the steps of:

(a) creating a plurality of rotated templates, wherein each one of the plurality of rotated templates comprises a set of transformed template data values determined at a different rotation angle relative to the orthogonal axes;

(b) for each of the plurality of rotated templates, creating a binary mask comprising:

(i) an active region having a shape and encompassing the set of transformed template data values, wherein an orientation of the active region matches an orientation of the rotated template relative to the orthogonal axes; and

(ii) a mask bounding region that is used for the quadrilateral template bounding region, the mask bounding region having a quadrilateral shape with a side aligned with one of the orthogonal axes and surrounding the active region, wherein an orientation of the mask bounding region remains fixed relative to the interactive display surface, and wherein dimensions of the mask bounding region are minimized to just encompass the active region;

(c) performing the step of Claim 2 using the mask bounding region as the quadrilateral template bounding region so that a different rotated mask integral sum is computed

for the input data values encompassed by each mask bounding region corresponding to each of the plurality of rotated templates, and so that the rotated mask integral sum is evaluated relative to the first threshold; and

(d) determining for which of the plurality of rotated templates the rotated mask integral sum of the rotated template most closely matches the sum of the set of template data values encompassed by the corresponding mask bounding region.

5. (Previously Presented) The method of Claim 4, wherein step (d) comprises the steps of:

(a) creating a list of rotated templates that are within the first threshold; and

(b) for each rotated template in the list, determining a distance between a first center associated with the mask bounding region corresponding to the rotated template and a second center associated with the mask bounding region used as the quadrilateral template bounding region;

(c) determining whether the distance is less than a redundancy threshold; and

(d) if the distance is less than the redundancy threshold, replacing the rotated template in the list with the rotated template corresponding to the mask bounding region used as the quadrilateral template bounding region.

6. (Original) The method of Claim 2, wherein the step of determining the integral sum comprises the steps of:

(a) computing an integral image array from the input data values, the integral image array comprising a plurality of array elements, each array element corresponding to one of the plurality of surface coordinate locations of the interactive display surface, and each array element comprising a sum of all input data values encompassed by a quadrilateral area from the surface origin to a corresponding surface coordinate location;

(b) selecting four array elements corresponding to four corners of the quadrilateral template bounding region, for association with a selected surface coordinate location and to align with the orthogonal axes; and

(c) computing the integral sum as a function of the four array elements, each of which represents an area encompassing input data values of the interactive display surface,

thereby determining the sum of input data values encompassed by the quadrilateral template bounding region as a function of sums of quadrilateral areas between the surface origin and the quadrilateral template bounding region.

7. (Original) The method of Claim 6, further comprising the step of associating the quadrilateral template bounding region with a succession of surface coordinate locations to determine an integral sum most closely matching the sum of the set of template data values, to detect a region of the interactive display surface to which the patterned object is adjacent.

8. (Original) The method of Claim 7, wherein a plurality of integral sums are determined for a plurality of mask bounding regions corresponding to a plurality of rotated templates at each of the succession of surface coordinate locations.

9. (Original) The method of Claim 1, wherein the difference score is calculated as one of a sum of absolute differences and a sum of squared differences.

10. (Original) The method of Claim 1, further comprising the steps of:

(a) computing a statistical moment of the set of template data values;

(b) computing a statistical moment of the input data values; and

(c) determining whether the statistical moment of the input data values is within a moment threshold percentage of the statistical moment of the set of template data values.

11. (Previously Presented) A computer-readable memory medium on which are stored machine instructions which, when executed upon one or more computer processors, perform each of the steps of Claim 1.

12. (Currently Amended) A system for detecting a patterned object, the system comprising:

(a) an interactive display surface having a surface origin, a plurality of surface coordinate locations defined along two orthogonal axes in relation to the surface origin, an interactive side adjacent to which the patterned object can be placed and manipulated, and an opposite side;

(b) a light source that directs infrared light toward the opposite side of the interactive display surface and through the interactive display surface, to the interactive side;

(c) a light sensor disposed to receive and sense infrared light reflected back from the patterned object through the interactive display surface;

(d) a processor in communication with the light sensor; and

(e) a memory in communication with the processor, the memory storing data and machine instructions that cause the processor to carry out a plurality of functions, the functions including:

preparing a stored template for runtime by:

loading a stored template,

computing an intensity sum of the stored template,

iteratively rotating the stored template in predefined increments through a full 360 degree rotation, and

computing moments of pixel intensities of the stored template, itself, from the rotated stored template image by determining a mean and covariance of pixel intensities of the rotated stored template image; ~~and also~~

~~[[(i)]]~~ detecting with the light sensor an intensity of the infrared light reflected back from the patterned object;

~~[[(ii)]]~~ creating a template of the patterned object at a known orientation, the template comprising a quadrilateral template bounding region having a side aligned with one of the two orthogonal axes; ~~[[and]]~~

creating a set of template data values associated with the quadrilateral template bounding region, each template data value representing an intensity of reflected infrared light at a different location within a bounding area encompassing the patterned object;

~~(iii) computing a sum of the set of template data values;~~

~~[[(iv)]]~~ acquiring input data values from the interactive display surface with the light sensor, each of the input data values corresponding to the intensity of infrared light reflected from a different one of the plurality of surface coordinate locations of the interactive display surface;

~~[[(v)]]~~ calculating a difference score between the template data values and the input data values encompassed by the quadrilateral template bounding region; and

~~[[(vi)]]~~ when the difference score is within a match threshold, determining that the patterned object is adjacent to the interactive surface.

13. (Original) The system of Claim 12, wherein the machine instructions further cause the processor to determine whether an integral sum of the input data values encompassed by the quadrilateral template bounding region is within a first threshold of the sum of the set of template data values, and if so continuing with calculating the difference score.

14. (Original) The system of Claim 12, wherein:

(a) the template data values comprise pixel values, each pixel value indicating an intensity of infrared light reflected from the patterned object while the patterned object is adjacent to the interactive display surface in a template acquisition mode; and

(b) the input data values comprise pixel values indicating an intensity of light reflected from the patterned object while the patterned object is adjacent to the interactive display surface in a run-time mode.

15. (Original) The system of Claim 14, wherein the machine instructions further cause the processor to:

(a) create a plurality of rotated templates, wherein each one of the plurality of rotated templates comprises a set of transformed template data values determined at a different rotation angle relative to the orthogonal axes;

(b) for each of the plurality of rotated templates, create a binary mask comprising:

(i) an active region having a shape and encompassing the set of transformed template data values, wherein an orientation of the active region matches an orientation of the rotated template relative to the orthogonal axes; and

(ii) a mask bounding region that is used for the quadrilateral template bounding region, the mask bounding region having a quadrilateral shape with a side aligned with one of the orthogonal axes and surrounding the active region, wherein an orientation of the mask bounding region remains fixed relative to the interactive display surface, and wherein dimensions of the mask bounding region are minimized to just encompass the active region;

(c) determine whether an integral sum of the input data values encompassed by the quadrilateral template bounding region is within a first threshold of the sum of the set of template data values by using the mask bounding region as the quadrilateral template bounding region so that a different rotated mask integral sum is computed for the input data values encompassed by each mask bounding region corresponding to each of the plurality of rotated templates, and so that the rotated mask integral sum is evaluated relative to the first threshold; and

(d) determine for which of the plurality of rotated templates the rotated mask integral sum of the rotated template most closely matches the sum of the set of template data values encompassed by the corresponding mask bounding region.

16. (Original) The system of Claim 15, wherein the machine instructions further cause the processor to:

(a) create a list of rotated templates that are within the first threshold; and

(b) for each rotated template in the list, determine a distance between a first center associated with the mask bounding region corresponding to the rotated template and a second center associated with the mask bounding region used as the quadrilateral template bounding region;

(c) determine whether the distance is less than a redundancy threshold; and

(d) if the distance is less than the redundancy threshold, replace the rotated template in the list with the rotated template corresponding to the mask bounding region used as the quadrilateral template bounding region.

17. (Original) The system of Claim 13, wherein to determine the integral sum, the machine language instructions further cause the processor to:

(a) compute an integral image array from the input data values, the integral image

array comprising a plurality of array elements, each array element corresponding to one of the plurality of surface coordinate locations of the interactive display surface, and each array element comprising a sum of all input data values encompassed by a quadrilateral area from the surface origin to a corresponding surface coordinate location;

(b) select four array elements corresponding to four comers of the quadrilateral template bounding region, for association with a selected surface coordinate location and to align with the orthogonal axes; and,

(c) compute the integral sum as a function of the four array elements, each of which represents an area encompassing input data values of the interactive display surface, thereby determining the sum of input data values encompassed by the quadrilateral template bounding region as a function of sums of quadrilateral areas between the surface origin and the quadrilateral template bounding region.

18. (Original) The system of Claim 17, machine language instructions further cause the processor to associate the quadrilateral template bounding region with a succession of surface coordinate locations to determine an integral sum most closely matching the sum of the set of template data values, to detect a region of the interactive display surface to which the patterned object is adjacent.

19. (Original) The system of Claim 18, wherein a plurality of integral sums are determined for a plurality of mask bounding regions corresponding to a plurality of rotated templates at each of the succession of surface coordinate locations.

20. (Original) The system of Claim 12, wherein the difference score is calculated as one of a sum of absolute differences and a sum of squared differences.

21. (Original) The system of Claim 12, machine language instructions further cause the processor to:

(a) compute a statistical moment of the set of template data values;

(b) compute a statistical moment of the input data values; and

(c) determine whether the statistical moment of the input data values is within a moment threshold percentage of the statistical moment of the set of template data values.

22 – 27. (Cancelled)